In the closing error of a cycle of observed clock rates, where each pair of successive hours of right ascension has been employed, with invariably the same stars in each hour, there are four conditions to consider, as influencing the results.

The errors of the adopted right ascensions enter every computed hourly rate, but these errors are completely eliminated in summing up the cycle.

Progressive change in instrumental corrections would produce progressive changes in computed clock rates, if undetected, and the performance of the meridian instrument has consequently received careful and rigorous treatment in this special series.

The difference between clock corrections observed at sunset and sunrise may be due to special conditions affecting the observed results at these two epochs of the day, or to a diurnal variation in the clock rate.

Progressive change in personal equation during the night would produce a computed change of observed clock rates.

The closing error of this series will be assumed to be due to either one or both of the last two conditions enumerated.

The summation of the observed clock rates gives the following means for successive pairs of hours from 9 P. M. to 3 A. M. The means are the excesses of observed hourly rates over the average daily rates of the clock at the corresponding epochs.

	s.
First two hours, excess	—0.002
Second two hours, excess	—0.003
Third two hours, excess	+0.005
Fourth two hours, excess	+0.005
Fifth two hours, excess	—0.000
Mean	+0.001
Average	±0.003

The probable error of observation for a rate from two successive hours, as summed up, is ±0.s002. The deviations from the mean of all are evidently fortuitous and there is no real progressive change such as would be due to the effect of fatigue or to periodic variation of the clock rate, unless these two effects balance each other.

The constancy of the reaction time, assuming uniform performance of the clock, should interest psychologists and physiologists, and the measure of its variations within errors of less than one one-hundredth of a second can be confirmed by other observers.

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LICK OBSERVATORY

PHYSIOLOGY OF STOMATA OF RUMEX PATIENTIA

THE behavior of the stomata of *Rumex patientia* has been studied for the past two years and, although the work has not been completed, the data at hand are sufficient to warrant the following conclusions:

1. The stomata close completely at night and check water loss from the intercellular spaces of the leaf.

2. When open the stomata modify the rate of water loss from the intercellular spaces of the leaf in proportion to changes in their perimeters, not to changes in their areas.

3. Light is the most important environmental factor, while acidity and the amount of water in the guard cells are the two internal conditions directly concerned with stomatal movements.

4. The guard cells contain green plastids which are structurally, physiologically and genetically different from the chloroplasts of the mesophyll.

5. The starch-sugar change in the guard cells is an equilibrium reaction and the point of equilibrium is shifted by changes in acidity. The guard cells change in acidity more readily than the mesophyll cells because their buffer content is low.

6. The series of changes which result in the opening of the stomata is as follows:

(*a*) In the morning the light changes the acidity of the guard cells.

(*b*) This change in acidity makes conditions more favorable for the hydrolytic action of diastase.

(*c*) The diastase in the guard cells changes the starch to sugar.

(*d*) The formation of sugar results in an increase in the osmotic pressure of the guard cells.

(*e*) Water enters the guard cells from the epidermal cells which do not change in pressure and causes them to swell.

(*f*) The swelling of the guard cells causes them to open because the thickened cell wall

around the pore stretches less than the thinner parts of the cell wall.

This series of changes does not take place if the leaves are wilted. If wilting occurs after the guard cells are open the point of equilibrium is shifted so that the sugar changes to starch and the guard cells close. If the leaves remain turgid the guard cells remain open until darkness and close by a reversal of this series of changes. These changes can be made to go in either direction by experimentally changing the acidity of the guard cells.

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A BOTANICAL SPELLING MATCH

"CAN one imagine a botanical or an entomological spelling match?" "Could 'aster' or 'grasshopper' be drawn in recognizable detail by the contestants?" These are two of the questions asked by Dr. C. E. Waters in SCIENCE for November 24.

The writer can not answer for entomology but he can for systematic botany. Formulæ may be used to express the structure of flowers. For example, the flower formula of the Boraginaceæ can be written $Ca^{\textcircled{5}}\ \overset{S^5}{\underset{\textcircled{5}}{Co}}\ P^{\textcircled{4}}$, of the Liliaceæ $Ca^3\ Co^3\ S^6\ P^{\textcircled{3}}$. In this way formulæ may be written for families, genera and species. The flower formula expresses concisely the following features: number of parts in the flower, kinds of parts, arrangement of parts, something of the shape of the flower and the position of the flower in evolution. On hearing or reading such a formula the structure and shape, as well as the taxonomic position, of the flower are immediately brought to mind. Surely it would not be difficult to imagine a spelling match in a class in systematic botany!

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SCIENTIFIC BOOKS

A GUIDE BOOK OF THE GEOLOGICAL SURVEY

THE fifth volume of the series of guide books of the western United States which our national geological survey has been producing in the last seven years is as attractive as its predecessors.

It deals with that portion of Colorado and Utah which is served by the Denver and Rio Grande Western Railway, a region visited by more tourists than any other portion of the country west of the Mississippi. To them this book would be a boon if it could be brought to their notice. Being an official publication bound in a grey paper cover it is not apt to be as widely known as it would be were it published by an enterprising publishing house, bound in bright red cover, placed in all the book stores, and mentioned in many magazines and circulars. But it is worthy of wide publicity because of its excellence. Campbell has beaten Baedeker at his own game. The book is charmingly written, beautifully illustrated and furnished with excellent maps.

The main part of the text presents in clear manner the succession of events which have resulted in the present Colorado and Utah. It does not go back just a few months or years, but begins far enough back to include the whole history of the region from earliest archæan times till 1922 A. D.

The foot notes in fine print contain the side lights on the main circuit. They deal with economic statistics, histories of individuals, explanations, definitions and illustrations of the main theme and are hardly less interesting or important than the main theme.

The central topic—the present constitution, structure and topography of the country and the forces which have produced them—is presented in a clear manner as entertaining as the talk of a clever man at a club. University students in that part of the country will no doubt use the volume as a text book since it may be obtained of the United States superintendent of documents for one fourth the price necessarily charged for the average geology, and since it is so practical and interesting. The average geological text book has the disadvantage of jerking the mind from one part of the world to the other for illustrations. This book illustrates point after point right on the spot. In the regions treated the reader can see nearly every principle of the earth's history strikingly set forth.

To apply geology to a definite locality is an